change the number of antenna ports on the fly, motivated by energy savings for example). However, increasing the number of CSI-RS ports on the fly can lead to additional puncturing of the PDSCH and increased interference at the UE, and hence a loss in performance.

**[0088]** Alternatively, decreasing the number of CSI-RS ports can create muted REs, assuming that PDSCH stays rate-matched around the set of CSI-RS REs prior to the change, which in turn reduces the overall spectral efficiency. In a case where the eNB activates/de-activates RE muting or modifies RE muting parameters (e.g., by an increase or decrease of the reuse factor) for inter-cell CSI measurements, then rate matching of the PDSCH around the set of muted REs should take place to avoid performance degradations, similar to the case of a change on the fly of the number of CSI-RS ports.

**[0089]** From the perspective of the exemplary embodiments of this invention muted REs can be considered to have the same impact as the CSI-RS REs. That is, they either (and possibly in some subframes together with CSI-RS) cause puncturing of the PDSCH or the PDSCH is rate matched around muted REs. In general, a muted RE is an RE with zero power from a certain cell, and the presence of muted REs can improve inter-cell measurements of a UE on CSI-RS for the purpose of DL transmission schemes that involve participation of more than one cell.

**[0090]** In the case where there is no common understanding between the UE and the eNB on what rate matching is used for the PDSCH transmission then it follows that the PDSCH transmission cannot be correctly decoded by the UE.

**[0091]** The exemplary embodiments of this invention address and solve these various problems and difficulties. It should be noted that the rate matching-related problem discussed above is applicable to all transmission modes (and not only to Rel-10 specific TMs).

**[0092]** Before describing in further detail the exemplary embodiments of this invention, reference is made to FIG. **2** for illustrating a simplified block diagram of various electronic devices and apparatus that are suitable for use in practicing the exemplary embodiments of this invention. In FIG. **2** a wireless network **1** is adapted for communication over a wireless link **11** with an apparatus, such as a mobile communication device which may be referred to as a UE **10**, via a network access node, such as a Node B (base station), and more specifically an eNB **12**. The network **1** may include a network control element (NCE) **14** that may include the MME/SGW functionality shown in FIG. **1**A, and which provides connectivity with a further network, such as a telephone network and/or a data communications network (e.g., the internet). The UE **10** includes a controller, such as at least one computer or a data processor (DP) **10**A, at least one non-transitory computer-readable memory medium embodied as a memory (MEM) **10**B that stores a program of computer instructions (PROG) **10**C, and at least one suitable radio frequency (RF) transceiver **10**D for bidirectional wireless communications with the eNB **12** via one or more antennas. The eNB **12** also includes a controller, such as at least one computer or a data processor (DP) **12**A, at least one computer-readable memory medium embodied as a memory (MEM) **12**B that stores a program of computer instructions (PROG) **12**C, and suitable RF transceivers **12**D for communication with the UE **10** via a plurality of antenna ports and antennas when multiple input/multiple output (MIMO) operation is in use. The eNB **12** is coupled via a data/control path **13** to the NCE **14**. The path **13** may be implemented as the S1 interface shown in FIG. **1**A. The eNB **12** may also be coupled to another eNB via data/control path **15**, which may be implemented as the X2 interface shown in FIG. **1**A.

**[0093]** For the purposes of describing the exemplary embodiments of this invention the UE **10** may be assumed to also include RRC/PHY (L1) functions **10**E, and the eNB **12** may be assumed to include a corresponding RRC/PHY (L1) functions **12**E. The eNB **12** RRC/PHY (L1) functions **12**E can be assumed to operate to provide the CSI-RS puncturing of the PDSCH, rate matching and related operations, as well as to perform RRC signaling to and from the UE **10**, and are enhanced for operation with the exemplary embodiments of this invention as described in further detail below. The UE **10** RRC/PHY (L1) functions **10**E can be assumed to operate to receive and interpret the CSI-RS puncturing of the PDSCH, to perform rate de-matching and related operations, as well as to perform RRC signaling to and from the eNB **12**, and are enhanced for operation with the exemplary embodiments of this invention as described in further detail below.

**[0094]** At least one of the PROGs **10**C and **12**C is assumed to include program instructions that, when executed by the associated DP, enable the device to operate in accordance with the exemplary embodiments of this invention, as will be discussed below in greater detail. That is, the exemplary embodiments of this invention may be implemented at least in part by computer software executable by the DP **10**A of the UE **10** and/or by the DP **12**A of the eNB **12**, or by hardware, or by a combination of software and hardware (and firmware).

**[0095]** In general, the various embodiments of the UE **10** can include, but are not limited to, cellular telephones, personal digital assistants (PDAs) having wireless communication capabilities, portable computers having wireless communication capabilities, image capture devices such as digital cameras having wireless communication capabilities, gaming devices having wireless communication capabilities, music storage and playback appliances having wireless communication capabilities, Internet appliances permitting wireless Internet access and browsing, as well as portable units or terminals that incorporate combinations of such functions.

**[0096]** The computer-readable MEMs **10**B and **12**B may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor based memory devices, random access memory, read only memory, programmable read only memory, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The DPs **10**A and **12**A may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multi-core processor architectures, as non-limiting examples.

**[0097]** In accordance with the exemplary embodiments of this invention, before the UE **10** has knowledge that the eNB **12** has correctly acquired the radio capabilities of the UE **10** (and thus the release (e.g., Rel-8, Rel-10) of the UE), the PDSCH transmission to the UE **10** is punctured by CSI-RS REs and both the eNB **12** and the UE **10** (i.e., the UE **10** and eNB **12** RRC/PHY (L1) functions **10**E, **12**E) use this assumption when transmitting/rate matching and receiving/de-rate matching, respectively) whenever PDSCH and CSI-RS happen to be transmitted in the same sub-frame.